International Journal of Physics
and Research (IJPR)
ISSN (P): 2250–0030; ISSN (E): 2319–4499
Vol. 11, Issue 2, Dec 2021, 63–68

TRANS STELLAR
•Journal Publications •Research Consultancy

Original Article

PHASE TRANSITION AND OPTICAL ANISOTROPY OF TERNARY MIXTURE OF LIQUID CRYSTALS WITH TEMPERATURE

P. SRINIVAS[1] & D. K. RAVISHANKAR[2]

[1]*Department of Physics, Sri Mahadeswara Govt First Grade College, Kollegal, Chamarajanagara, Karnataka, India*

[2]*Department of Chemistry, Sri Mahadeswara Govt First Grade College,Kollegal, Chamarajanagara, Karnataka, India*

ABSTRACT

The goal of this study is to look at how texture changes as a function of temperature in a mixture of liquid crystalline materials. The effects of temperature on optical anisotropy measurements have also been studied. The organic liquid crystal compound 4-(2-methylbytyl) phenyl 4-(4-octylphenyl) benzoate(CE8) is a ferroelectric liquid crystal composed of rod-like molecules that exhibits a chiral smectric phase with stable Blue phase, Diethyl 4,4lAzoxydicinnamate exhibits a cholesteric liquid crystalline phase, and Cholesteryl nonanoate exhibits a choleste When a mixture of 4-(2-methylbytyl) phenyl 4-(4-octylphenyl) benzoate(CE8),Diethyl4,4lAzoxydicinnamate, and Cholesteryl nonanoate molecules in equal proportions is cooled from its isotropic phase, it shows cholesteric, SmA, and SmE successively. This is found to exhibits for all different concentrations of given mixture. The phase transition have been characterised using polarising microscopic technique. The temperature variations of optical anisotropic measurements shows that the refractive indices of liquid crystalline ternary mixture shows almost non linear increase in extraordinary refractive index while non linear decrease and then increase in ordinary refractive index, when specimen is cooled from its isotropic phase. The temperature variations of optical anisotropic measurements have noted using Goniometer spectrometer.

KEYWORDS: Ternary Mixture, Phase Transition, Optical Texture & Optical Anisotropy

Received: Oct 01, 2021; **Accepted**: Oct 20, 2021; **Published**: Dec 23, 2021; **Paper Id.**: IJPRDEC20217

1. INTRODUCTION

Many materials that exhibit liquid crystalline behaviour fall into one of two categories: Thermotrophics and Lyotropics. Transition into mesophases obtained by purely thermal process is called “Thermotrophics” where as in which mesophases are obtained by the influence of a solvent on solid is called “Lyotropics”. Thermotropic liquid crystals generally exhibits three types of Phases, namely, Nematic, Cholesteric and Smectic phase. Liquid crystalline materials and their mixture exhibit a multitude of transitions involving new phases with changing temperature. Studies of these phases are of significance in a wide range of scientific fields. Liquid crystalline compounds exhibit optical anisotropy, which has remarkable significance. The temperature dependence of optical anisotropy of liquids crystals is due to the change in their molecular order with temperature. Thethermotropic liquid crystal 4-(2-methylbytyl) phenyl 4-(4-octylphenyl) benzoate(CE8) is a ferroelectric liquid crystal composed of rod-like molecules shows a chiral smectricphase, the organic compound Diethyl 4,4[l]Azoxydicinnamateis a thermotropic liquid crystal exhibits Smectic phase with molecular formula $C_{18}H_{18}N_2O_4$ and melting point is around 110^0C .The thermotropic organic compound Cholesterylnonanoate exhibits Cholesteric liquid crystalline phase with helical structure, its molecular formula being $CH_3 (CH_2)_7 COOC_{27} H_{45}$ and melting point is 77^0 C to 82^0C. In the present investigation textural changes of mixture of 4-(2-methylbytyl) phenyl 4-(4-octylphenyl) benzoate, Diethyl 4,4[l]Azoxydicinnamateand cholesterylnonanoate as a function of temperature is observed and recorded. The present

investigation also covered the temperature variations of refractive indices of liquid crystalline ternary mixture.

II. MATERIAL AND METHODS

The mixtures of varied amounts of liquid crystal substances 4-(2-methylbytyl) phenyl 4-(4-octylphenyl)benzoate, Diethyl4,4lAzoxydicinnamate, and Cholesteryl nonanoate were synthesised in the current study. Desiccators were used to keep mixes of varied concentrations of samples for a long time. To achieve homogeneity, the samples went through many cycles of heating, stirring, and centrifuging. The samples are sandwiched between the slide and the coverslip, and then properly sealed for microscopic examination. With the help of a Gippon-polarising microscope and a hot stage, the optical textures of these mixes at various temperatures are examined and recorded.The refractive indices are measured by the method of minimum deviation using Goniometer spectrometer. The temperature of sample is increased by increasing the voltage across the terminals of spectrometer.

III. OPTICAL TEXTURE STUDIES

The sample's Molecular Orientations of Optical Textures were examined and recorded using a Gippon polarising microscope and a hot stage. The specimen is taken in the shape of a thin film with sand witched between the slide and the covering slip in each case. When a ternary combination with equal proportions of 4-(2-methylbytyl) phenyl 4-(4-octylphenyl) benzoate, 33.3 percent of Diethyl 4,4lAzoxydicinnamate, and 33.3 percent of Cholesteryl nonanoate molecules is cooled from the isotropic phase, it shows cholesteric, SmA, and SmE phases consecutively. This has been taken down. The genesis of nucleation begins when the sample is cooled from its isotropic phase in the form of small bubbles developing radially, which are identified as spherulitic textures of the cholesteric phase, as illustrated in figure 1(a) and figure 1(b) (b). From 1380C to 1330C, the cholesteric phase ends. As the specimen cools more, the texture gradually changes to a composite of Isogyres-like structure and SmA phase. This composition of Isogyres like structure and SmA phases exits from 133^0C to 124^0C, shown in fig1(c) and figure 1(d).On further cooling the specimen, the unstable SmA phase changes to SmE phase as shown in fig1(e) .TheSmE phases exits from 124^0C to 120^0C. The specimen enters to crystalline phase from 120^0C.

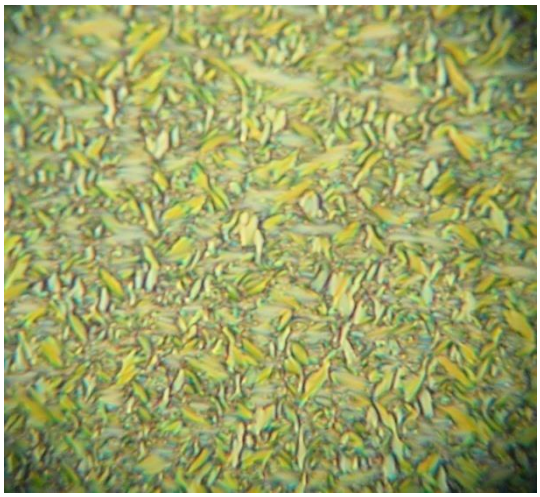

Figure 1(a)

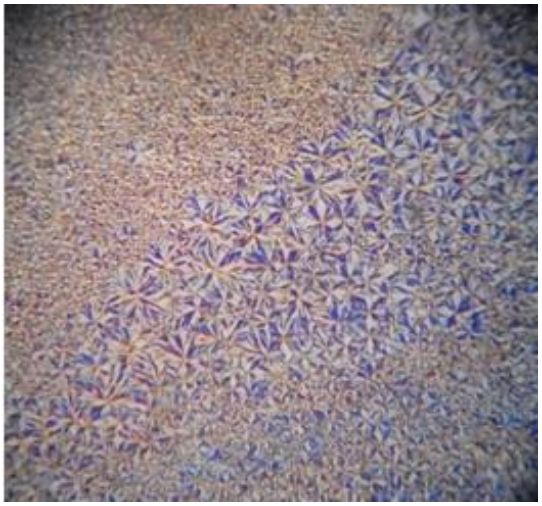

Figure 1(b)

Figure 1(c)

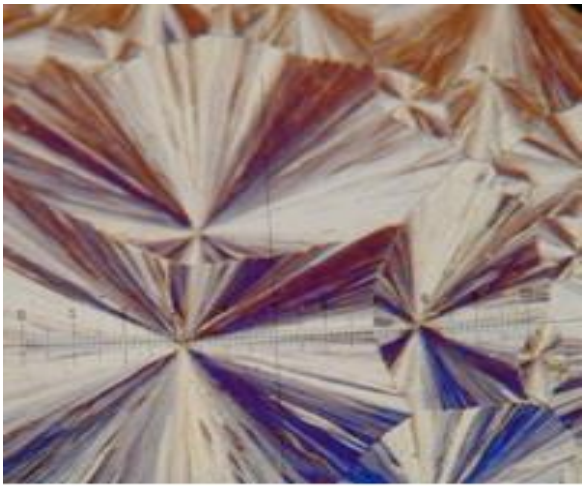

Figure 1(d)

Figure 1(e)

Figure 1: Microphotographs Obtained between the Crossed Polars.
1(a) and 1(b)Spherulitic Texture of Cholesteric Phase(250 X)
1(c) and 1(d).Texture of ofSmAphase(250 X),
1(e).Texture of ofSmEphase(250 X),

IV. OPTICAL ANISOTROPY

Temperature dependency of refractive indices for mixture of 33.3% of 4-(2-methylbytyl) phenyl 4-(4-octylphenyl) benzoate, 33.3% of Diethyl 4,4^{l}Azoxydicinnamate and 33.3% of Cholesterylnonanoateis presented in Figure (2). It is clear that, the value of extraordinary refractive index is more than the ordinary refractive index for all temperatures. The value of extraordinary refractive index remains same from 138^{0}C to 135^{0}C, then increases non-linearly from 135^{0} C to 122^{0} C when specimen is cooled from its isotropic phase. The value of ordinary refractive index remains same from 138^{0}C to 135^{0}C, then decreases from 135^{0}C to 133^{0}C and increases non-linearly from 133^{0} C to 122^{0} C when specimen is cooled from its isotropic phase.

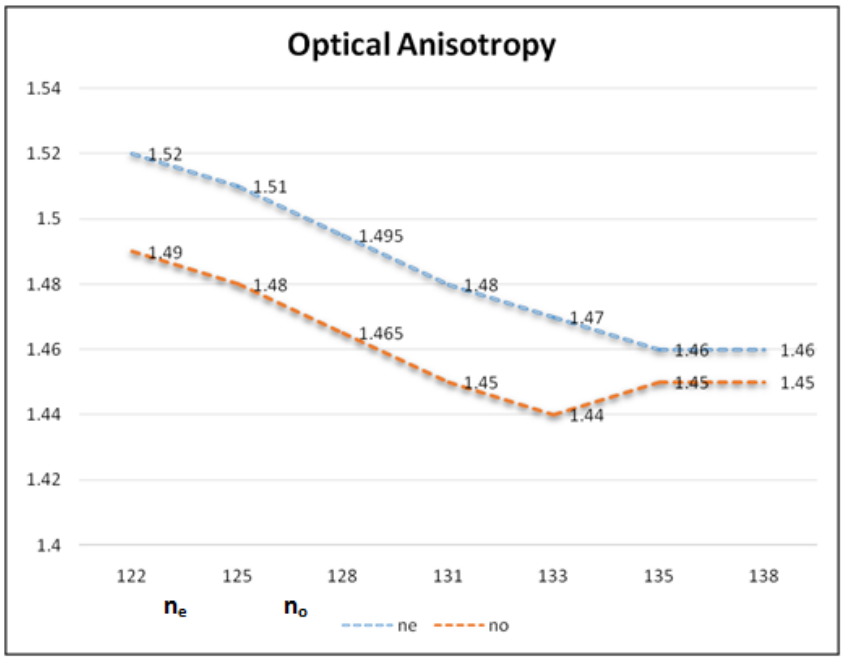

Figure 2

V. CONCLUSIONS

Microscopic analysis of a ternary liquid crystal compound combination When chilled from isotropic phase, 33.3 percent of 4-(2-methylbytyl) phenyl 4-(4-octylphenyl) benzoate, 33.3 percent of Diethyl 4,4lAzoxydicinnamate, and 33.3 percent of Cholesterylnonanoate molecules display cholesteric, SmA, and SmE phases successively. The optical texture studies for the ternary combination clearly show the above successive phase alterations. When chilled from its isotropic phase, the temperature changes of refractive indices of liquid crystalline ternary mixture show practically non linear increase in extraordinary refractive index and non linear drop and then increase in ordinary refractive index. The structural diversity of the liquid crystalline state is demonstrated to be mirrored in their optical anisotropy.

REFERENCES

1. *Govindaiah.T.N.,Sreepad.H.R., Nagappa and Mahadeva.J.(2014). Mol.Cryst.liq.cryst.593,51-60.*
2. *Mahadeva, J and Govindaiah.T.N, Optical and Electro optical studies on liquid crystalline material, Mol.cryst.liq.cryst.,631,646(2016).*
3. *Porov.P.et.al, Optical studies of dye doped cholesteric liquid crystal, Journal of liquid crystals, V-1 (2016)*
4. *Mahadeva, J.et.al, Optical studies on cholesteric and sematic phases of Ternary mixtures of liquid crystalline materials, proceedings of National level seminar on crystallography, Bharathi college, Bharathinagar, Karnataka(2018).*
5. *Nagappa, Nataraj, & Krishnamurthy, D(1986).Mol.Cryst.Liq.Cryst.133,31*
6. *A.S.Govinda, Theoritical study of liquid crystals in thin cell,27th National Conference on Liquid crystals(2020),Amity University, UttarPradesh.*
7. *Santhos Mam,, Phase transition of liquid crystals doped with cabon nanotubes,27th National Conference on Liquid crystals(2020),Amity University, UttarPradesh.*

8. *8. Joshi, M. P., and S. S. Thipse. "An evaluation of algae biofuel as the next generation alternative fuel and its effects on engine characteristics: A review." International Journal of Mechanical and Production Engineering Research and Development (IJMPERD) 9 (2019): 435-440.*

9. *URADE, PRADNYA P., Chandrakanth U. Mehetre, and SHRIRAM H. MAHURE. "Cm arative Study of Properties of Self Compacting Concrete with Ground Granulated Blast Furnace Slag and Fly Ash as Admixtures." International Journal of Civil, Structural, Environmental and Infrastructure Engineering Research and Development (IJCSEIERD) ISSN (P): 2249-6866.*

10. *Rao, K. Jagannadha, and Mohammed Abdul Mujeeb. "Effect of crumb rubber on mechanical properties of ternary blended concrete." Research and Development (IJCSEIERD) 3.3 (2013): 29-36.*

11. *Jacob, Anoop, and Nivin Philip. "A review on high performance concrete." International Journal of Civil Engineering (IJCE) 4.6 (2015): 39-46.*